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ENGINEERING AND EXPERIMENTAL DEVELOPMENT

OF LIQUID FUEL CATAPULTS

Combined Progress Report for December 1952

TM - 465

EXPERIMENT INCORPORATED
Richmond 2, Virginia

Submitted to Department of the Army - Ordnance Corps as partial fulfillment of requirements under Contract DA-36-034-ORD-763.

[redacted]

[redacted]

[redacted]

A complete account of the development which led to the establishment of the present program, including a list of pertinent publications describing details of the earlier torpedoal work, was included in the first status report of this series (Experiment Incorporated TM-439). This report also contained a description of the scope of such work under present investigation, and a list of abbreviations to whom distribution of reports prepared under Contract DA-36-034-ORD-763 is authorized. Inasmuch as the scope mentioned above will not be repeated in this or subsequent combined progress reports, TM-439 should be preserved as a reference.

A systematic procedure for identification and numbering of the various liquid fuel catapult models previously tested at this Laboratory has been outlined in a previous publication (Experiment Incorporated T. P. No. 20). This procedure will be followed in respect to all models designed in the course of the present program.

PHASE I - STUDY OF [redacted] MIXING AND [redacted] PROCESS

[redacted]

The hydrazine-hydrogen peroxide vapor-droplet system has been demonstrated to be extremely sensitive to trace catalysts.

I. Theoretical Studies

There is no work to report this month.

II. Experimental Studies

A. Vapor-Droplet Apparatus

The apparatus has been performing very satisfactorily during this report period, and no changes or adjustments have been necessary.

B. Droplet-Vapor Tests

Experiments were undertaken with the system hydrazine vapor-hydrogen peroxide droplets employing [redacted] materials. The time delay to reaction

was greater than 450 milliseconds, i.e., the droplet ignited on the bottom of the tube if ignition occurred at all. Previous determinations for 92% H_2O_2 had given an ignition delay of 295 milliseconds.

This large difference in observed delay is evidently due to trace catalysis. With the addition of roughly one part per million of potassium cyanide to the hydrogen peroxide, the droplet began to burn in 43 milliseconds with a total burning time of roughly 43 milliseconds. It is apparent that careful control over impurities will be required in subsequent studies of this fuel-oxidant combination, and that prospects for uncovering trace catalysts capable of producing extremely short delays should be excellent.

PHASE II - EXTENSION OF ENGINEERING STUDIES OF HIGH PRESSURE STATIC AND DYNAMIC SEALS AND MEANS FOR DISSIPATION OF HIGH IMPACT LOADS

SUMMARY

The static-dynamic testing machine was proof tested at its design limit and attained a piston velocity of 74 ft./sec. The source of major equipment difficulties was located and is being eliminated. Several 127 mm liquid fuel catapult components were successfully pressure proof tested.

I. Theoretical and Design Studies

Several adapter components for the multi-part piston, M-9, and a metal type "C" ring, M-6D (cut to facilitate radial expansion at relatively low pressures) were designed and fabricated.

II. Static-Dynamic Test Program

A. Apparatus and Instrumentation

Erratic pressure-time results, a continuous source of difficulty, were minimized by relocation of instrumentation equipment to reduce vibrational feed-back. The origin of most equipment difficulties proved to be the gas collector, which applied a huge side thrust to the relatively flexible support rods of the S-D machine as a result of the rapid high pressure gas release. A ring is being fabricated that will transfer this thrust to the rigid low pressure cylinder and base plate. Much less vibration and lateral motion is expected during high velocity test runs by installation of this ring.

B. Seal Testing

Type M-9 piston and M-6D seals were quasi-statically tested to 5000 psi. The M-6D seal maximum leakage was approximately 20 cc/sec. at

C. Catapult Component [illegible]

The check valve for the 127 mm catapult was proof tested satisfactorily in the 40,000 psi range. A second incorporating positive bleed features also was tested; the result suggested a modification which improved the bleed action on a subsequent trial. The 127 mm igniter was proof tested to 44,000 psi, according to the low pressure gauge reading and the intensification ratio. A copper crusher gauge which gave a pressure indication of 43,500 psi was also used simultaneously in the igniter crystal pickup holder. This pressure correspondence was considered good, indicating an approximately 1.3% variation.

D. Impact Absorption Testing

The constant deceleration impact absorber was used in ordnance instrumentation testing to eliminate causes of various difficulties, in the course of which the load machine was run at its maximum [illegible] capacity for the first time. With balance pressure 1000 psi. and an accelerating pressure of 1100 psi., the resulting piston velocity was [illegible] ft./sec., comparing favorably with design expectations.

PHASE III - EXPANSION OF EXPERIMENTAL STUDIES WITH A 90 MM LIQUID PROPELLANT GUN

SUMMARY

The muffler system, mounting rails, carriage and gun have been installed at the new test facility. The remote loading and firing mechanisms are being attached. It is expected that the firing program will begin the latter part of January, commencing with several [illegible] solid propellant rounds to ascertain the adequacy of the installation, the control system, pressure-time and velocity instrumentation.

PHASE IV - ENGINEERING DESIGN OF A PROTOTYPE LARGE CALIBER REGENERATIVE LAUNCHER

SUMMARY

This phase has been completed.

PHASE V - CONSTRUCTION AND PRELIMINARY TEST OF A LARGE CALIBER REGENERATIVE LAUNCHER

SUMMARY

[illegible] breech assembly for adaptation to the 127 mm launcher has